

Long Lake- 2017 Survey Report
Steve Hogler, Steve Surendonk and Derek Apps,
WDNR Fisheries-Green Bay

ABSTRACT

Long Lake is a drainage lake located in western Manitowoc County. The lake has a surface area of 120 acres and a maximum depth of 38 feet. The lake is moderately developed with residences and has public access on the northeast corner of the lake.

Since the 1940's fish surveys have been conducted on Long Lake. Over time, abundant, desirable species such as Northern Pike, Largemouth Bass, Yellow Perch and fast growing Bluegill have been replaced by Carp, Bullhead and slow growing panfish. During this same period water quality in the lake has also declined. The fish population was further perturbed by a large fish kill that occurred in 1984. Comprehensive fish surveys in 1999 and 2007 found that the most abundant fish were Bluegill followed by Black Crappie and Yellow Bass. The most common gamefish were Largemouth Bass and Northern Pike. In 2011, a nighttime electroshocking survey was conducted to assess bass and panfish populations. Results from this one night survey were similar to results from previous May electroshocking surveys with Bluegill and Largemouth Bass dominating the catch.

Long Lake has had a history of fish kills that go back many decades. A copper sulfate treatment for aquatic plant control in the summer of 1984 caused a major fish kill. Fish Management suggested a rotenone treatment and restocking, but lake residents voted not to eradicate the remaining fish. More recently, fish kills in 2004, 2007, 2008 and 2011 caused by poor water quality, *Columnaris* or spawning stress have affected mostly panfish and Largemouth Bass. In 2017, lake residents reported a fish kill that impacted mostly Black Crappie, Bluegill and a few Largemouth Bass.

A comprehensive fisheries survey was conducted on Long Lake in April and May, 2017 to assess the fish populations of the lake. Two survey gears, fyke nets and a boomshocker was used to collect fish across the spring spawning seasons. In total, 6,936 fish representing thirteen species were captured. Overall, Black Crappie and Bluegill dominated our catch.

It is recommended to continue to survey Long Lake every 5 years, to evaluate abundance and growth rates of gamefish and panfish and to work with the Lake Association, shoreline residents and Manitowoc County to improve water quality and to restore nearshore fish habitat in the lake.

INTRODUCTION

Long Lake (WBIC-0077500) is a drainage lake located in western Manitowoc County (T19N, R21E, Sections 6 and 7) (Figure 1). The lake has a surface area of 120 acres, a maximum depth of 38 feet and a shoreline development factor of 2.22. The lake basin is divided into two lobes and the lake bottom is a mixture of muck and gravel. Long Lake is surrounded by agricultural land, has hard water and is impounded by a low head dam. The lake is moderately developed with residences along the western shore. Long Lake has public access on the northeast corner of the lake.

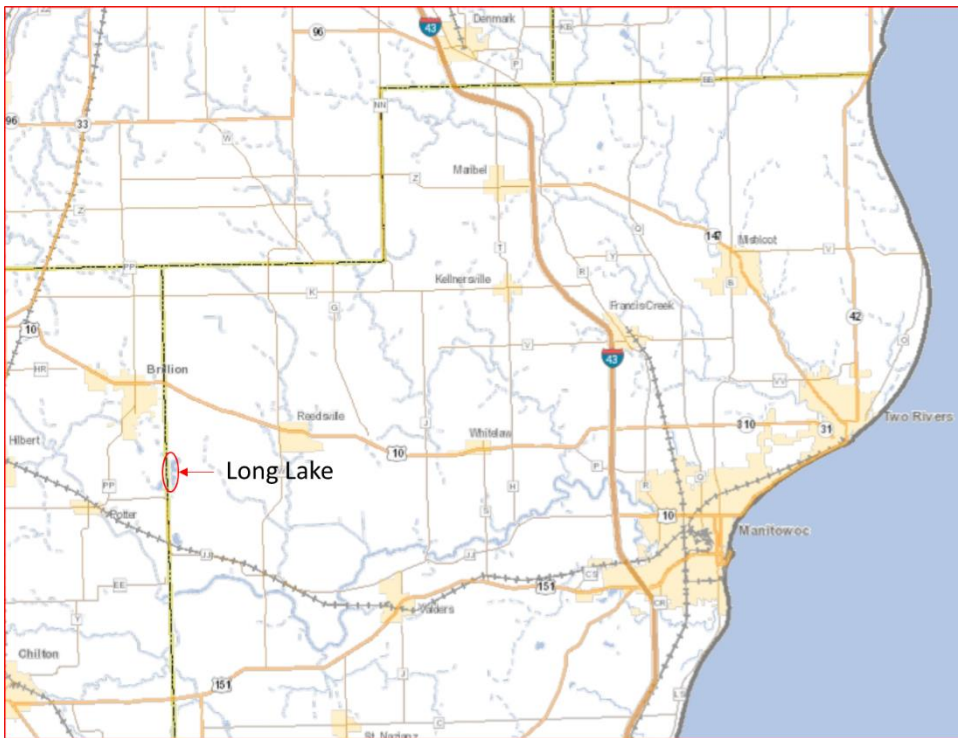


Figure 1. Long Lake is located on the western edge of Manitowoc County, west of the city of Manitowoc.

Fish surveys have been conducted on Long Lake since the 1940's. Mackenthun (1947) found an abundance of Bluegill, Crappie, Largemouth Bass and Northern Pike that exhibited good growth with many Bass greater than 20 inches in length and several Northern Pike greater than 40 inches. Very few Walleye were captured, and it was believed that Long Lake was not suited for Walleye because of the lack of spawning sites. Many large and small Carp were collected and there

was concern about potential Carp problems in the future. Mackenthun also collected a few Yellow Bass. He noted the lack of forage fish in lake, poor water quality (low dissolved oxygen), and heavy plankton growth.

A 1958 trap net survey by Hacker (1958) collected 1,324 fish, with Black Crappie and Bluegill dominating the catch. Northern Pike, Largemouth Bass, and Walleye were commonly caught with Bullheads and Carp captured in lower number. A 1963 electroshocking survey (Schultz 1963) had similar results, with Bluegill the most commonly collected species, followed by Black Crappie, Largemouth Bass and Carp. Northern Pike and Yellow Bass were collected, but in much lower numbers. Schultz also noted abundant filamentous algal growth and recommended copper sulfate to lake residents to control algae.

Belonger (1973) surveyed the lake with seines and electroshocking gear and found fish populations in poor condition. He found large numbers of Carp, Bullhead, and small panfish. Gamefish populations, chiefly Northern Pike and Largemouth Bass, were common and grew at a good rate, but appeared to be heavily exploited by anglers. It was recommended that a complete chemical treatment along with construction of a fish barrier on the outlet to prevent reintroduction of Carp be pursued.

A 1978 fyke net survey (Welch 1983) and an electroshocking survey (Peeters 1981) found similar conditions as those observed by Belonger (1973). Gamefish populations were healthy and exhibited good growth. Numerous panfish were captured but they were small in size. Large numbers of Carp were also collected. Also noted were planktonic algal blooms and low dissolved oxygen levels (Welch 1983).

A comprehensive fish survey of Long Lake in 1983 found a diverse fish community (Hogler 1999). The Largemouth Bass population was abundant with a wide range of sizes present in the lake. Northern Pike and Walleye were low in number, but large in size. Panfish populations were large in number, but small in size. Forage species were low in number. The low number of gamefish and small size of panfish may have been caused by limited forage or by anglers over harvesting larger individuals. Carp and Bullhead were present in the lake. Declines in water quality and algal blooms were also noted.

A 1999 comprehensive fish survey along with a creel survey on Long Lake characterized the fish populations of the lake (Hogler 2001). During this survey, a total of 7,474 fish were collected that represented sixteen species. The most abundant fish were Bluegill followed by Black Crappie and Yellow Bass. The most common gamefish were Largemouth Bass and Northern Pike. The creel survey estimated that anglers during the open water fishing season fished 16,046 hours and harvested 7,782 fish. Yellow Bass, Bluegill and Black Crappie were the most commonly harvested fish. Conclusions from this survey were that although Largemouth Bass and Northern Pike populations were fair, variable recruitment

negatively impacted their abundance. Panfish were numerous but small in size. The small size may be due to angler harvest of larger individuals or lack of forage because length at age analysis indicated growth to be near state averages.

In 2007, a comprehensive survey utilizing fyke nets in spring followed by early summer electrofishing was conducted on Long Lake (Hogler and Surendonk 2008). A total of 1,524 fish were collected representing thirteen species. Overall the most abundant fish were Bluegill followed by Black Crappie and Northern Pike. Largemouth Bass, Walleye, Carp and Bullhead were also commonly captured. Survey results from this survey were consistent with the findings of previous surveys with fair gamefish populations that exhibited good growth and abundant panfish that were small in size.

The last fisheries survey of Long Lake was done in 2011. A nighttime electroshocking survey was conducted to assess bass and panfish populations (Hogler and Surendonk 2012). Results from this one night survey were similar to results from past May electroshocking surveys with Bluegill and Largemouth Bass dominating the catch. Age and growth in 2011 was similar to age and growth from previous surveys. Long Lake remained a bass-bluegill lake based on survey results. Fish are generally small, not because of slow growth, but because of young age. It is likely that angler harvest has impacted the size structure of fish in Long Lake. Missing or weak year classes of gamefish were noted in the length and age frequencies and are likely due to poor water quality or unfavorable spawning conditions.

Long Lake has had a history of fish kills that go back many decades. A copper sulfate treatment for aquatic plant control in the summer of 1984 caused a major fish kill (Peeters 1984). It was believed that low dissolved oxygen killed nearly all the Northern Pike, Walleye and Yellow Bass, 60 to 80% of the Largemouth Bass, 30 to 60% of the panfish and Carp and less than 1% of the Bullhead found in the lake. Fish Management suggested a rotenone treatment and restocking, but lake residents voted not to eradicate the remaining fish.

More recently, a 2004 kill affecting mostly Bluegill was investigated (Hogler 2004). The cause of this kill was determined to be from *Columnaris*, a bacterium found in soil that causes gill erosion. A large fish kill in 2007 affected primarily Yellow Bass (Hogler 2007). It was estimated that least 5,000 Yellow Bass died with lab analysis indicating that gill erosion and liver condition in the sampled fish were similar to what is seen when fish are exposed to high levels of ammonia or super-saturated oxygen levels. Poor water quality in Long Lake likely was a contributing factor in the kill. Samples from the fish were also cultured to determine if bacteria or a virus contributed to the kill. Results indicated that a small, non-VHS virus was detected in the fish samples. The cause of the kill remains unknown although it is likely the combination of poor water quality and the virus contributed to the fish kill. Fish kills that occurred in 2008 and 2011 affected mostly panfish and resulted from a combination of spawning stress and *Columnaris* (Hogler 2008, Hogler and

Surendonk 2011).

In 2017 lake residents reported a fish kill that impacted mostly Black Crappie, Bluegill and a few Largemouth Bass (Hogler 2017). Based on WDNR investigation, all dead fish had been dead a number of days based on the fish being desiccated or covered in mold. Live fish appeared to be healthy without any visual signs of distress. Staff noted that the lake was much more turbid than during our previous visit. The cause of the increased turbidity and the cause of the kill is unknown but could be the result of heavy rainfall at a time that fish were stressed by spawning events and warming water.

The Long Lake Association has been an active partner in managing Long Lake. They have sponsored several Lake Planning and Management Grants through the WDNR Water Resources program, collected water quality data, operated a lake aerator, conducted an experimental Carp removal project, installed spawning reefs, created a Northern Pike spawning marsh and with WDNR stocked fish into the lake (Table 1). WDNR stocked the majority of fish, but the Association has contributed by stocking those fish denoted as being from a private hatchery.

Table 1. Long Lake, Manitowoc County fish stocking records since 1972.

Year	Species	Age Class	Number Stocked	Average Length (in)	Source
1972	NORTHERN PIKE	ADULT	200	15	FEDERAL HATCHERY
1972	NORTHERN PIKE	YEARLING	100	13	FEDERAL HATCHERY
1974	NORTHERN PIKE	YEARLING	100	15	FEDERAL HATCHERY
1983	NORTHERN PIKE	FINGERLING	300	11	DNR HATCHERY
1984	LARGEMOUTH BASS	FINGERLING	250	6	FEDERAL HATCHERY
1985	NORTHERN PIKE	FRY	120000	1	DNR HATCHERY
1985	NORTHERN PIKE	ADULT	20	15	FEDERAL HATCHERY
1985	NORTHERN PIKE	FINGERLING	600	9	DNR HATCHERY
1985	LARGEMOUTH BASS	FINGERLING	1598	4	DNR HATCHERY
1985	LARGEMOUTH BASS	FINGERLING	1200	1	PRIVATE HATCHERY
1986	NORTHERN PIKE	FRY	120000	1	DNR HATCHERY
1986	NORTHERN PIKE	FINGERLING	600	9	DNR HATCHERY
1986	LARGEMOUTH BASS	FINGERLING	1200	3	DNR HATCHERY
1988	LARGEMOUTH BASS	FRY	5000	2	DNR COOP PONDS
1991	NORTHERN PIKE	FINGERLING	200	9	PRIVATE HATCHERY
2002	NORTHERN PIKE	FINGERLING	250	13	PRIVATE HATCHERY
2003	WALLEYE	FINGERLING	5995	1.5	DNR HATCHERY
2003	NORTHERN PIKE	FINGERLING	1000	3.4	DNR HATCHERY
2004	NORTHERN PIKE	FINGERLING	260	11	PRIVATE HATCHERY
2005	WALLEYE	FINGERLING	5980	1.4	DNR HATCHERY
2005	NORTHERN PIKE	FINGERLING	2997	3.1	DNR HATCHERY
2008	NORTHERN PIKE	YEARLING	280	20	PRIVATE HATCHERY
2009	WALLEYE	FINGERLING	4185	1.8	DNR HATCHERY
2010	WALLEYE	FINGERLING	500	7	PRIVATE HATCHERY
2011	WALLEYE	FINGERLING	4615	1.9	DNR HATCHERY
2012	NORTHERN PIKE	FINGERLING	294	12	PRIVATE HATCHERY
2013	NORTHERN PIKE	FINGERLING	792	8.3	DNR HATCHERY
2013	WALLEYE	FINGERLING	4195	2	DNR PONDS
2015	YELLOW PERCH	YEARLING	1180	6	PRIVATE HATCHERY
2015	NORTHERN PIKE	FINGERLING	831	8.9	DNR HATCHERY
2015	WALLEYE	FINGERLING	4434	1.7	DNR HATCHERY
2017	WALLEYE	FINGERLING	4447	1.7	DNR HATCHERY

METHODS

Spring Fyke Netting

A standard comprehensive fisheries survey on Long Lake began in April and continued through May 2017. Seven fyke nets were set on April 5 and were lifted through April 8 when the nets were tied open to let fish swim through. The nets were closed on April 10 and fished through April 14 (Figure 2). Fyke nets were set to capture and mark adult spawning Northern Pike, Walleye and Yellow Perch. Biological data was collected from all fish that were captured in the nets. Fish were identified and measured, spines, rays or scales were removed from a sub-sample of species for age determination and all gamefish were marked with a caudal fin clip for use in calculating a population estimate.

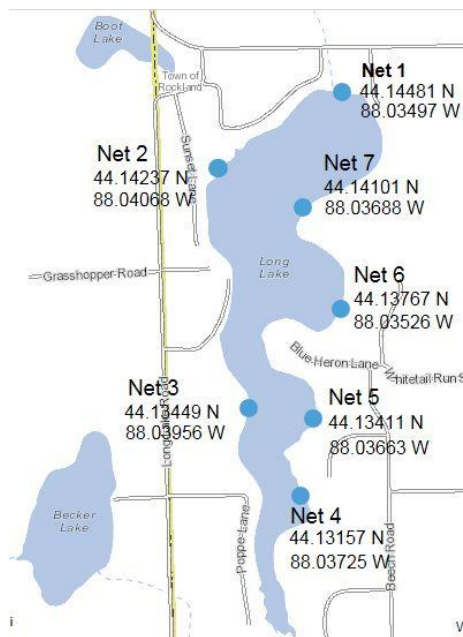


Figure 2. Spring 2017 fyke net locations on Long Lake.

Spring Electrofishing

Recapture Run

Shortly after the completion of fyke netting, on the night of April 24, the entire shoreline of Lake was electroshocked to look for marked fish. All fish were netted, identified, checked for marks and measured.

Centrarchid Electrofishing

On the night of May 22, the entire shoreline was electroshocked to estimate adult Largemouth Bass and panfish relative abundance. All fish were netted, identified, checked for marks and measured.

Statistical Analyses

Basic fisheries statistics, such as average length, length frequencies by survey type, age distributions, and population estimates were calculated when possible. Mean length at age was determined first by using an age length key to extrapolate length age distributions from the sub-sample of fish that were aged to the full sample length frequency, then second calculating the arithmetic mean of the length for a given age from the estimated full sample age distribution.

The Petersen population estimation method was used to estimate community population size when the recapture numbers were large enough to provide an unbiased estimate of population size. For the Petersen method, population size was estimated as the ratio between the number of fish initially marked and released during the marking period (M), times the number of fish captured and examined for marks (C) during the recapture period, divided by the number of fish that were found to have marks during the recapture period (R) using the Petersen estimator (Ricker 1975).

RESULTS

Spring Fyke Netting

During the fyke net portion of the survey, a total of 6,331 fish were captured during the 49 net nights fished for a Catch per Effort (CPE) of 129.2 fish per net per night. Of the twelve species captured, Black Crappie, and Bluegill dominated the catch, with fewer Northern Pike, Brown Bullhead Largemouth Bass and Walleye netted (Table 2).

Table 2. The number of each species that were captured with fyke nets fished during April 2017 in Long Lake. Catch per unit effort, (CPE) is expressed as the number of fish per net per night. Lengths are reported in mm and in inches (") for each species.

Species	Number Caught	CPE	Size Range	Average Length
Northern Pike	297	6.1	335 mm- 946 mm (13.2"- 37.2")	660 mm (26.0")
Largemouth Bass	84	1.7	82 mm- 508 mm (3.2"- 20")	410 mm (16.1")
Walleye	61	1.2	395 mm- 682 mm (15.6"- 26.9")	508 mm (20")
Black Crappie	4611	94.1	116 mm- 296 mm (4.6"-11.7")	200 mm (7.9")
Bluegill	1044	21.3	84 mm- 202 mm (3.3"- 8")	158 mm (6.2")
Yellow Perch	7	0.1	163 mm- 213 mm (6.4"- 8.4")	182 mm (7.2")
Pumpkinseed Sunfish	5	0.1	157 mm- 172 mm (6.2"- 6.8")	165 mm (6.5")
Yellow Bass	3	0.1	295 mm- 309 mm (11.6"- 12.2")	302 mm (11.9")
Brown Bullhead	170	3.5	176 mm- 382 mm (6.9"- 15.0")	276 mm (10.9")
Black Bullhead	2	0.0	263 mm- 299 mm (10.4"-15.7")	281 mm (11.1")
Carp	32	0.7		
Golden Shiner	15	0.3		
Total	6331	129.2		

Gamefish

Northern Pike

Northern Pike were the most commonly caught gamefish with a CPE of 6.1 fish per net per night (Table 2). The 297 Pike that were captured ranged in length from 335 mm to 946 mm (13.2" to 37.2") and had an average length of 660 mm (26") (Table 3). Of the Northern Pike that were captured, 48.8% (144 of 295) were greater in length than the 660 mm (26") minimum harvest length for Pike on Long Lake (Figure 3). Most of the captured Pike ranged in length from 580 mm (22.8") to 820 mm (32.3") with fewer smaller or larger Pike captured. 159 of the 295 captured Pike (53.9%) were male and had an average length of 660 mm (26"). The 136 female Pike averaged 723 mm (28.5") in length.

Table 3. The length distribution of fish caught during the April 2017 survey on Long Lake.

Length (in) mm	Northern Pike	Walleye
330	2	
390	1	1
(16") 400		3
410	1	1
420	1	1
430	1	2
440		3
(16") 450		4
460		1
470	2	7
480	3	5
490	4	4
(20") 500	7	6
510	7	2
520	5	4
530	3	3
540	3	1
(22") 550	4	0
560	5	0
570	10	3
580	20	1
590	12	2
(24") 600	7	4
610	14	0
620	13	0
630	6	0
640	10	0
(26") 650	10	0
660	9	2
670	12	1
680	11	1
690	5	
(28") 700	11	
710	5	
720	9	
730	8	
740	4	
(30") 750	7	
760	7	
770	8	
780	9	
790	8	
(32") 800	8	
810	1	
820	7	
830	5	
840	2	
(34") 850	2	
860		
870	2	
880		
890		
36") 900	1	
910	1	
920		
930		
940	2	
950		
Total	295	62
Ave. Length	660 (26")	508 (20.0")
S.D.	107.7 (4.2")	68.1 (2.7")

Length (in) mm	Largemouth Bass	Black Crappie	Bluegill	Brown Bullhead
40			3	
(2") 50				
60				
70				
80	2		2	
90				
(4") 100			8	
110		1	11	
120			32	
130			53	
140			59	
(6") 150		9	89	
160	1	24	178	
170		90	147	1
180		198	31	1
190		279	1	1
(8") 200		395	1	1
210		234		3
220		88		2
230		18		4
240	1	5		8
(10") 250		1		9
260				14
270				8
280				17
290		1		19
(12") 300	1			13
310	1			9
320				2
330	4			
340	3			1
(14") 350	2			
360	1			
370	1			
380	3			1
390	5			
(16") 400	8			
410	5			
420	5			
430	6			
440	11			
(16") 450	6			
460	6			
470	5			
480	3			
490	1			
(20") 500	3			
Total	84	1343	615	114
Ave. Length	410 (16.1")	200 (7.9")	157 (6.2")	276 (10.9")
S.D.	76.7 (3.1")	15.3 (0.6")	17.9 (0.7")	37.2 (1.5")

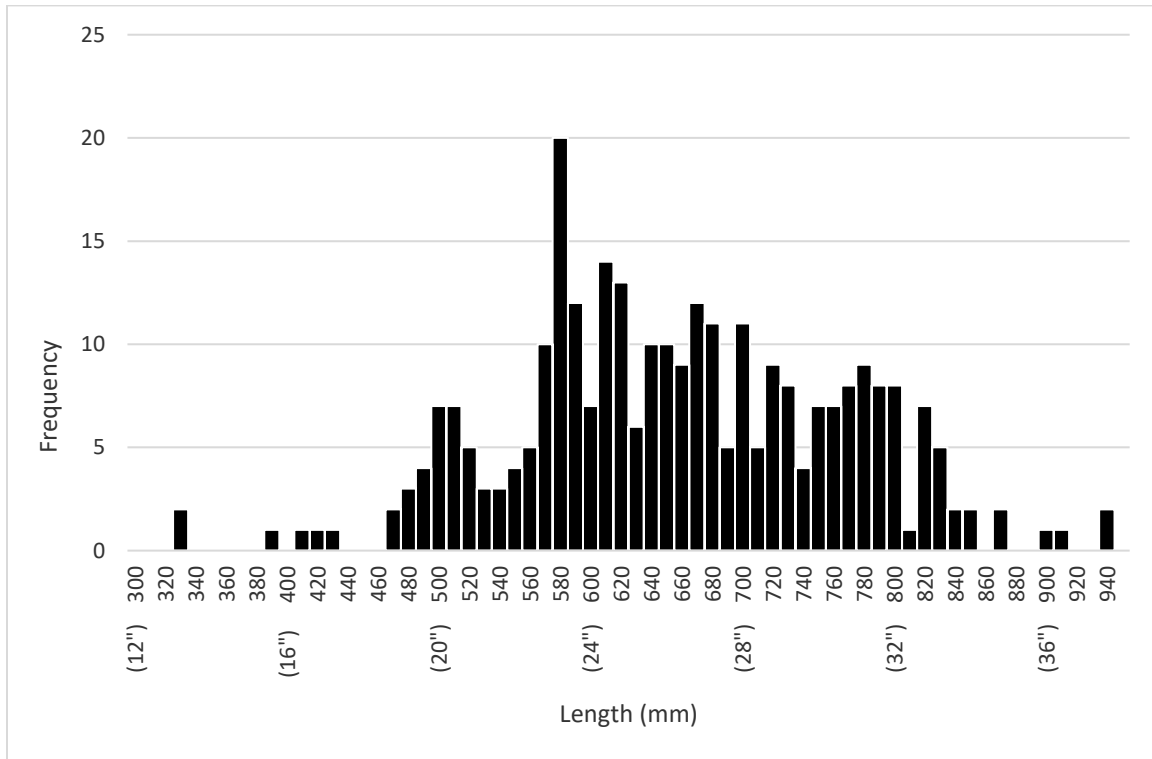


Figure 3. The length frequency distribution of Northern Pike captured during fyke netting on Long Lake, April, 2017.

An anal ray was collected from 291 Northern Pike for age analysis. To increase sample size, male and female Pike age estimates were pooled. Analysis of the age sample yielded age 2 through age 12 Northern Pike (Table 4). Age 4 was the most common age followed by age 5 Pike. Other ages were encountered in lower numbers. When the average length of each age group was compared to Statewide averages, Northern Pike in Long Lake are longer at ages 2 through 6 indicating above average growth in young Pike (Table 5). Older Pike in Long Lake appear to grow slower than same age Pike in other State lakes.

Table 4. The age distribution of Northern Pike captured during the April 2017 fyke survey on Long Lake.

Length (in) mm	Age										
	2	3	4	5	6	7	8	9	10	11	12
330	1	1									
390	1										
(16") 400		1									
410		1									
420	1										
430	1										
440											
(18") 450											
460											
470	1	1									
480		3									
490	1	3									
(20") 500	3	2	2								
510	1	3	2	1							
520	1	1	3								
530		3									
540	1		2								
(22") 550		2	1	1							
560	1	1	2	1							
570		2	8								
580		2	9	5	1						
590		2	6	3	1						
(24") 600		1	1	2	1	2					
610		3	8	1	1	1					
620		1	5	4	3						
630			3	2	1						
640		1	6	1	1	1					
(26") 650			6	3	1						
660		1	2	1		2	1	2			
670			3	2	2		2	3			
680		1	3	1	2		3	1			
690			1	2				1	1		
(28") 700			4	1		2	2		1		1
710			1	1	1	1		1			
720			1			1	3	3		1	
730		1	5	2							
740			3	1							
(30") 750			3	2			1		1		
760			1	2	1			2			
770			5	2	1						
780			2	7							
790			2	4	1		1				
(32") 800			3	3				1	1		
810			1								
820				5			1				
830			1	1				2	1		
840				1			1				
(34") 850				1					1		
860											
870				2							
880											
890											
(36") 900									1		
910										1	
920											
930											
940									2		
(38") 950											
Total	13	37	105	65	18	10	15	16	9	2	1
Ave. Length	478 (18.8")	546 (21.5")	652 (25.7")	712 (28.0")	659 (26.0")	673 (26.5")	723 (28.5")	727 (28.6")	825 (32.5")	816 (32.1")	709 (27.9")
S.D.	64.3 (2.5")	78.8 (3.1")	83.2 (3.3")	95.3 (3.8")	60.1 (2.4")	54 (2.1")	57.7 (2.3")	58.2 (2.3")	96.2 (3.8")	135.1 (5.3")	--

Table 5. Average length at age for selected species captured during fyke net surveys on Long Lake in 2017 compared to previous Long Lake surveys, 1983 (Hogler 1999), 1999 (Hogler 2001) and 2007 (Hogler and Surendonk 2008) and statewide average length at ages (WDNR 1990). Lengths are reported in mm and inches (in).

Species	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10	AGE 11
Northern pike											
2017 survey	--	478 (18.8")	546 (21.5")	652 (25.7")	712 (28.0")	659 (26.1")	673 (26.5")	723 28.5	727 28.6	825 32.5	
2007 survey	--	350 (13.8")	557 (21.9")	578 (22.8")	654 (25.7")	686 (27.0")	--	--	--		
1999 survey	143 (5.6")	311 (12.2")	455 (17.9")	547 (21.5")	617 (24.3")	664 (26.1")	716 (28.2")	787 (31.0)	910 (35.8")		
1983 survey	291 (11.5")	454 (17.8")	554 (21.8")	639 (25.1")	702 (27.6")	736 (29.0")	804 (31.7")	829 (32.6")			
State Average	356 (14.0")	406 (16.0")	470 (18.5")	546 (21.5")	610 (24.0")	650 (25.6")	706 (27.8")	762 (30.0")	787 (31.0")		
Largemouth Bass											
2017 Survey	--	166 (6.5")	240 (9.4")	--	319 (12.5")	362 (14.3")	411 (16.2")	431 (17.0")	448 17.6")	468 (18.4")	
2007 survey	--	--	317 (12.5")	327 (12.8")	376 (14.8")	388 (15.3")	446 (17.6")	460 (18.1")	--	--	--
1999 survey	68 (2.7")	138 (5.4")	216 (8.5")	279 (11.0")	330 (13.0")	369 (14.5")	406 (16.0")	437 (17.2")	460 (18.1")	481 (18.9")	492 (19.4")
1983 survey	66 (2.6")	141 (5.5")	213 (8.4")	271 (10.6")	326 (12.8")	372 (14.6")	409 (16.1")	435 (17.1")	454 (17.8")	474 (18.7")	488 (19.2")
State Average	97 (3.9")	165 (6.5")	229 (9.0")	290 (11.4")	338 (13.8")	384 (15.1")	414 (16.3")	447 (17.6")	454 (17.9")	485 (19.1")	
Walleye											
2017 Survey	--	--	--	447 17.6")	490 (19.3")	516 (20.3")	510 (20.1")				
2007 survey	--	--	--	--	--	--					
1999 survey	151 (6.0")	341 (13.4")	446 (17.6")	503 (19.8")	531 (20.9")	555 (21.8")					
1983 survey	209 (8.2")	345 (13.6")	444 (17.5")	514 (20.3")	567 (22.3")	643 (25.2")					
State Average	152 (6.0")	254 (10.0")	324 (12.8")	381 (15.0")	432 (17.0")	457 (18.0")					
Bluegill											
2017 Survey	--	84 (3.3")	111 (4.4")	134 (5.3)	163 (6.3")	172 (6.8")	184 (7.2")				
2007 survey	99 (3.9")	113 (4.5")	169 (6.6")	187 (7.3")	--	--	--				
1999 survey	46 (1.8")	84 (3.3")	124 (4.9")	155 (6.1")	175 (6.8")	191 (7.5")	209 (8.1")				
1983 survey	43 (1.7")	90 (3.5")	143 (5.6")	169 (6.6")	188 (7.4")	--	--				
State Average	64 (2.5")	97 (3.9")	122 (4.8")	147 (5.8")	167 (6.6")	183 (7.2")	196 (7.7")				
Black crappie											
2017 Survey	--	--	--	182 (7.2")	198 (7.9")	216 (8.5")	218 (8.5")	221 (8.7")	240 (9.4")		
2007 survey	--	137 (5.4")	207 (8.1")	224 (8.8")	244 (9.6")	253 (10.0")					
1999 survey	53 (2.1")	107 (4.2")	146 (5.7")	173 (6.8")	197 (7.7")	201 (7.9")					
1983 survey	56 (2.2")	113 (4.5")	153 (6.0")	182 (7.2")	205 (8.1")	228 (8.9")					
State Average	79 (3.1")	137 (5.4")	183 (7.2")	218 (8.6")	241 (9.5")	267 (10.5")					

Walleye

During the fyke net survey 61 Walleye were captured with a CPE of 1.2 fish per net per night (Table 2). Walleye ranged in length from 395 mm to 682 mm (15.6" to 26.9") and had an average length 508 mm (20") (Table 2). Most Walleye were between 400 mm (16") and 540 mm (21.3") in length (Figure 4). All captured Walleye were greater than the 381 mm (15") minimum size limit for harvest.

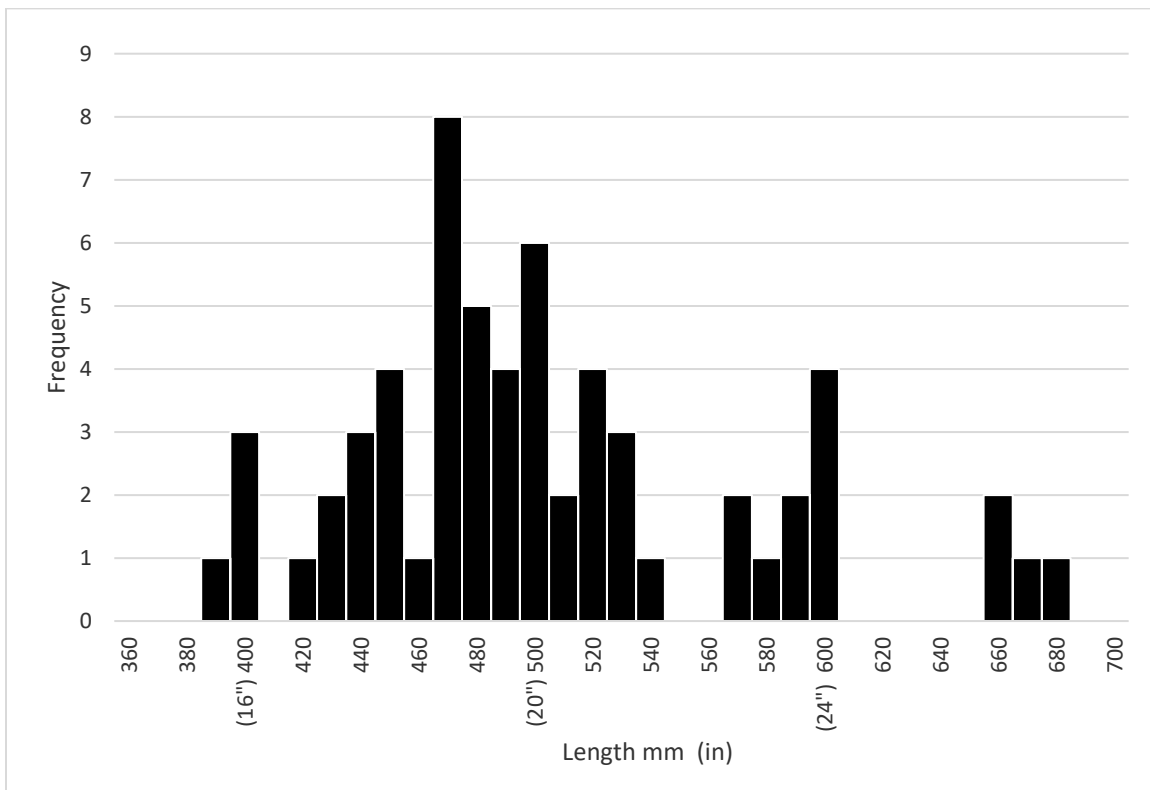


Figure 4. The length frequency distribution of Walleye captured during fyke netting on Long Lake, April, 2017.

A dorsal spine was removed from all captured Walleye for age analysis. Age 4 through age 7 and ages 12 and 14 were identified in our sample (Table 6). Ages 6 and 7 were the most common with fewer Walleye of other age classes identified. Walleye average length at age for ages 4 through 7 was above Statewide averages indicating good growth.

Table 6. The age distribution of Walleye captured during fyke netting on Long Lake, April 2017.

Length		Age										
(in)	mm	4	5	6	7	8	9	10	11	12	13	14
	390	1										
(16")	400	3										
	410				1							
	420	1										
	430	2										
	440	2			1							
(18")	450	1		1	2							
	460			1								
	470	2		4	1							
	480	1		2	2							
	490		1	1	2							
(20")	500	1		4	1							
	510	1		1								
	520			1	3							
	530			2	1							
	540				1							
(22")	550											
	560											
	570			1	2							
	580				1							
	590			1	1							
(24")	600			3	1							
	610											
	620											
	630											
	640											
(26")	650											
	660									2		
	670											1
	680									1		
Total		15	1	22	20	0	0	0	0	3	0	1
Ave Length		447 (17.6")	490 (19.3")	516 (20.3")	511 (20.2")	--	--	--	--	670 (26.4")	--	675 (26.6")
S.D.		38.6	--	48.2 (1.9")	51.4 (2.0")	--	--	--	--	10.1 (0.4")	--	--

Largemouth Bass

Although not an early spawning fish, 84 Largemouth Bass were captured during fyke netting (Table 2). CPE for Bass was 1.7 per net per night. Captured Bass ranged in length from 82 mm to 508 mm (3.2" to 20") and had an average length of 410 mm (16.1") (Table 3). Most of the captured Bass were greater than 300 mm (12") in length with 82.1% of the Bass greater than 356 mm (14") in length (Figure 5). 28.6% of the Bass were longer than 457 mm (18") in length.

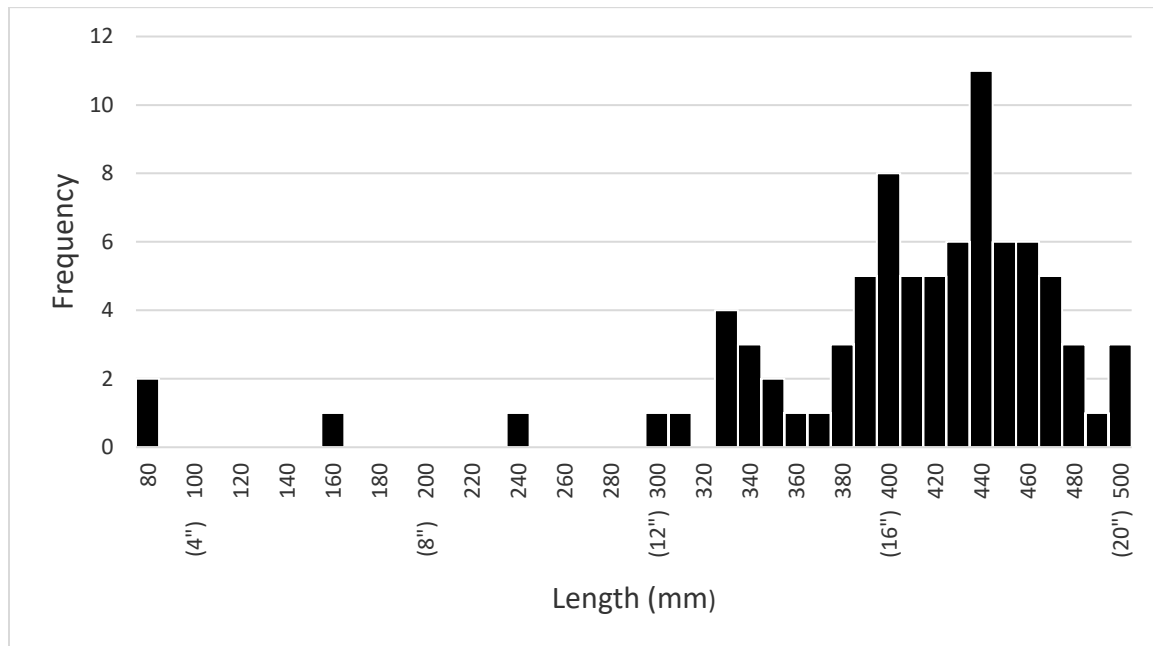


Figure 5. The length frequency distribution of Largemouth Bass captured during fyke netting on Long Lake, April, 2017.

A dorsal spine was collected from 82 of the captured Largemouth Bass to evaluate the age and growth of Bass in Long Lake. Age 1 through age 3 and age 5 through age 12 were identified in that sample that was analyzed (Table 7). Age 7 was the most common followed by age 8 Bass. Other ages were less commonly encountered. When length at age for Largemouth Bass from Long Lake was compared to Statewide values, Bass in Long Lake were at or slightly below average in length at all ages compared to Bass from other lakes in Wisconsin (Table 5). Growth compared to the previous survey in 2007 had slowed but was similar to other surveys conducted on Long Lake.

Table 7. The age distribution of Largemouth Bass captured during fyke netting on Long Lake, April 2017. Lengths are in mm and inches (in).

Length (in) mm	Age											
	1	2	3	4	5	6	7	8	9	10	11	12
80	2											
90												
100												
110												
120												
130												
140												
150												
160		1										
170												
180												
190												
(8") 200												
210												
220												
230												
240			1									
(10") 250												
260												
270												
280												
290												
(12") 300						1						
310						1						
320												
330						3	1					
340					1		2					
(14") 350					1		1					
360							1					
370						1						
380						2	1					
390						1	2	1	1			
(16") 400						2	3	3				
410							1	4				
420							4		1			
430							2	3	1			
440							6	3	1	1		
(18") 450								2	3	1		
460							1		3	1	1	
470								2	1	1	1	
480										2		1
490												1
(20") 500											3	
Total	2	1	1	0	2	11	25	18	11	6	5	2
Ave. Length	82 (3.2")	166 (6.5")	240 (9.4")		349 (13.7")	362 (14.3")	411 (16.2")	431 (17.0")	448 (17.6")	468 (18.4")	489 (19.3")	487 (19.2")
S.D..	--	--	--		5.7 (0.2")	36.5 (1.4")	37.5 (1.5")	24.0 (0.9")	23.8 (0.9")	16.3 (0.6")	19.9 (0.8")	4.2 (0.2")

Panfish

Black Crappie

Black Crappie were the most abundant fish captured during the fyke net survey with a CPE of 94.1 caught per net per night (Table 2). Of the 4,611 Crappie captured, 1,343 were measured. Measured Crappie ranged in length from 116 mm

to 296 mm (4.6" to 11.7") and had an average length of 200 mm (7.9") (Table 2). Most Crappie were between 180 mm (7.1") and 210 mm (8.3") with few larger or smaller fish captured (Figure 7).

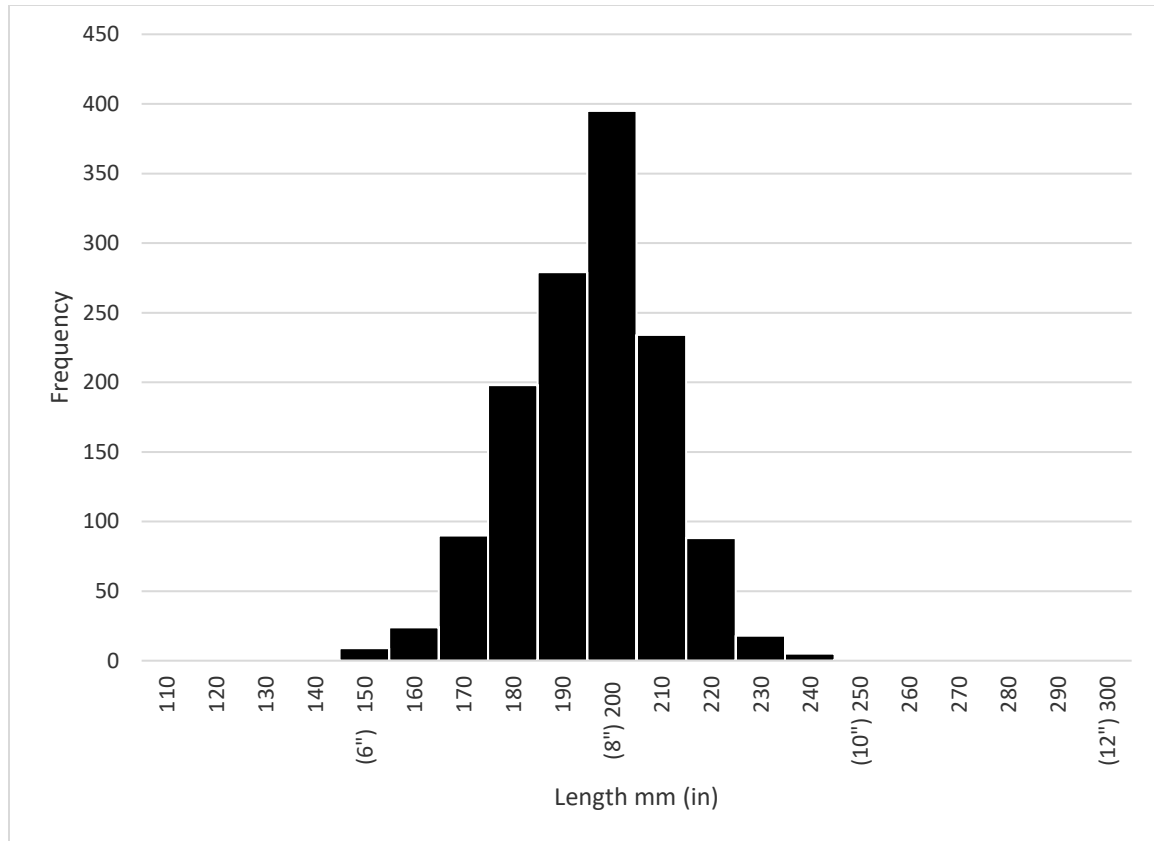


Figure 6. The length frequency distribution of Black Crappie captured during fyke netting on Long Lake, April, 2017.

Scales were collected from a subsample of the measured Crappie for analysis of age and growth. Ages 4 through 9 were identified in the sample (Table 8). Age 4 Crappie were the most common followed by ages 5, 6 and 7. Age 8 and age 9 Crappie were much less commonly encountered. When compared to Statewide average length at age, Black Crappie from Long Lake grew slower than Crappie from other lakes (Table 5). Growth in 2017 was less than measured from the 2007 survey, but similar to surveys conducted in 1983 and 1999.

Table 8 Black Crappie length frequency and age distribution for fish that were captured with fyke nets during the 2017 survey. The age distribution of the entire measured catch was a projection based on the distribution of ages from scale samples. Lengths are reported in mm and in inches ().

Length (in) mm		Age									
		Total	1	2	3	4	5	6	7	8	9
	110	1									
	120										
	130										
	140										
(6")	150	9				9					
	160	24				24					
	170	90				90					
	180	198				155	43				
	190	279				230	39		10		
(8")	200	395				11	150	130	52	52	
	210	234				18	18	77	102	19	
	220	88						8	36	36	8
	230	18						6	6	5	1
	240	5						2	3		
(10")	250	1									
	260										
	270										
	280										
	290	1									1
Total		1343	0	0	0	537	250	223	209	112	10
Ave. Length		200 (8")				182 (7.2")	198 (7.8")	216 (8.5")	218 (8.6")	221 (8.7")	240 (9.4")
S.D..		15.3 (0.6")				14.1 (0.6")	8.9 (0.4")	13.1 (0.5")	11.5 (0.5")	17.6 (0.7")	

Bluegill

A total of 1,044 Bluegill with a CPE of 21.3 fish per net per night were captured during fyke netting (Table 2). The 615 Bluegill that were measured ranged in length from 84 mm to 202 mm (3.3" to 8") and had an average length of 158 mm (6.2") (Table 2). 447 of 615 measured Bluegill (72.7%) were greater in length than 150 mm (6") but the abundance of Bluegill larger than 175 mm (6.9") declined rapidly with only one fish greater in length than 200 mm (8") (Figure 7).

Scales were used to age Bluegill. Age 1 through age 7 were identified in our sample (Table 9). Age 5 Bluegill were the most common followed by ages 5 and 6. Other aged Bluegill were substantial lower in number. Bluegill average length at age was at of slightly less than Statewide ages for Bluegill in other lakes across Wisconsin (Table 5). Bluegill growth in 2017 was less than observed from the 2007 survey, but similar to previous surveys conducted in 1983 and 1999.

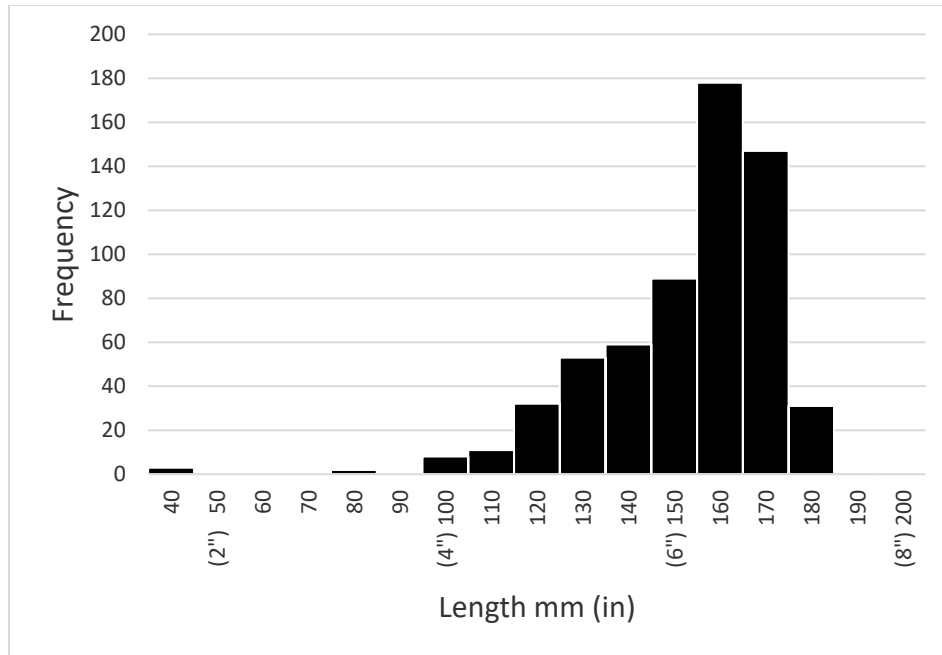


Figure 7. The length frequency distribution of Bluegill captured during fyke netting on Long Lake, April, 2017.

Table 9. Bluegill length frequency and age distribution for fish that were captured with fyke nets during the 2017 survey. The age distribution of the entire measured catch was a projection based on the distribution of ages from scale samples. Lengths are reported in mm and in inches ().

Length (in) mm	Age							
	Number	1	2	3	4	5	6	7
40	3	3						
(2") 50								
60								
70								
80	2		2					
90								
(4") 100	8			8				
110	11			8	3			
120	32			4	28			
130	53				42	11		
140	59				25	34		
(6") 150	89				27	45	17	
160	178				7	75	89	7
170	147				9	69	62	7
180	31					12	19	
190	1							1
(8") 200	1							1
Total	615	3	2	20	141	246	187	16
Ave. Length	158 (6.2")	43 (1.7")	84 (3.3")	111 (4.4")	134 (5.3")	163 (6.4")	172 (6.8")	184 (7.2")
S.D.	21.4 (0.8")	1.2 (0.1")	--	6.9 (0.3")	14.1 (0.6")	14.8 (0.6")	8.7 (0.3")	20.1 (0.8")

Other Species

During fyke netting other species were captured that included, in decreasing order of abundance, Brown Bullhead, Common Carp, Golden Shiner, Yellow Perch, Pumpkinseed Sunfish, Yellow Bass and Black Bullhead (Table 2). The average length of the panfish were 182 mm (7.2") for Yellow Perch, 165 mm (6.5") for the Pumpkinseed Sunfish and 302 mm (11.9") for Yellow Bass.

Spring Electrofishing

Recapture Run

During the night of April 24, the entire 2.18 mile shoreline was electroshocked to look for fish marked during fyke netting and to determine relative abundance of Common Carp. During the 1.6 hours of electrofishing, 136 fish representing four species were netted (Table 10). Water temperature at the time of survey was 55°F. Largemouth Bass and Common Carp dominated the catch with substantially fewer Northern Pike and Walleye captured. Total CPE was 62.4 fish per mile shocked or 85.0 fish per hour shocked.

Table 10. The number of each species that were captured by electrofishing during the night of April 24, 2017 in Long Lake. Lengths are reported in mm and in inches (") for each species.

Species	Number Caught	CPE (fish/mile)	CPE (fish/hour)	Size Range	Average Length	Peterson P.E.	P.E. Range
Largemouth Bass	75	34.4	46.9	223 mm- 525 mm (8.8"-20.7")	382 mm (15")	--	--
Northern Pike	6	2.8	3.8			255	126-557
Walleye	1	0.5	0.6			31	9-55
Carp	54	24.8	33.8				
Total	136	62.4	85.0				

Gamefish

Largemouth Bass

Largemouth Bass dominated the gamefish catch during the electrofishing recapture run. The 75 captured Bass ranged in length from 223 mm to 525 mm (8.8" to 20.7") and had an average length of 382 mm (15") (Table 2). 43 of the 75 captured Bass (57.3%) were greater than the 356 mm (14") minimum size for harvest and nine (35.4%) were greater than 457 mm (18") (Figure 8).

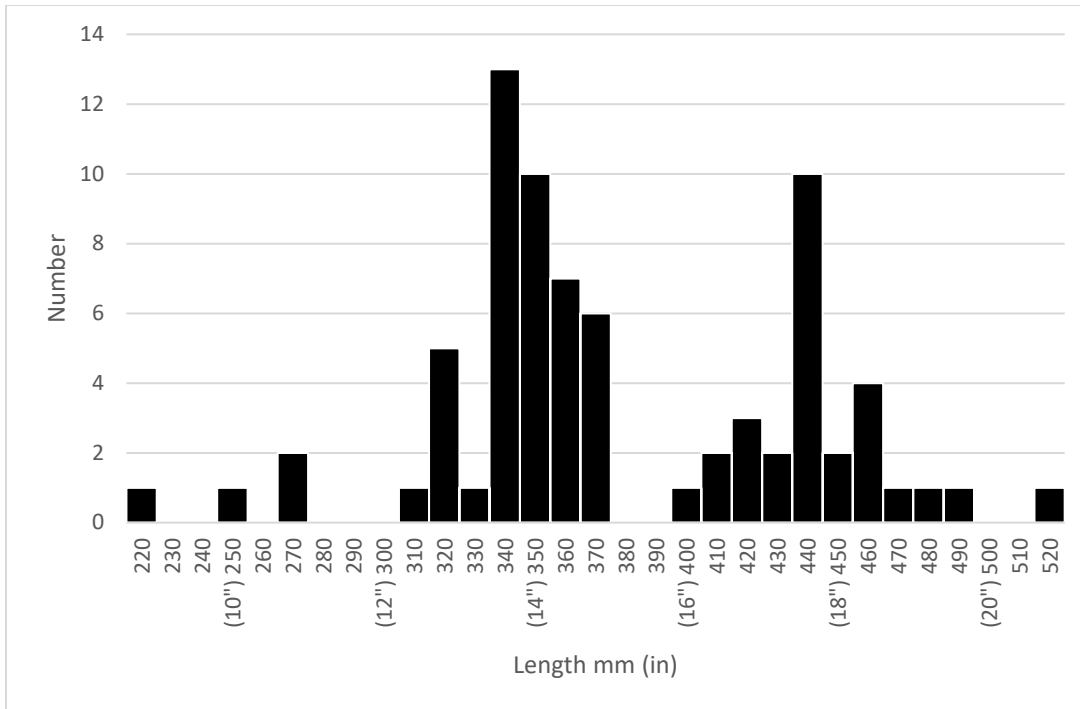


Figure 8. The length frequency distribution of Largemouth Bass captured during the April, 2017 recapture electroshocking on Long Lake.

No Bass were recaptured with a mark given during fyke netting so a population estimate could not be calculated.

Northern Pike and Walleye

During the recapture run, all six Pike and the single netted Walleye were recaptured fish with marks given during the fyke net survey (Table 10). The Peterson Population Estimates (PE) and ranges were 255 (range 126 to 557) for Northern Pike and 31 (range 9 to 55) for Walleye. These estimates and ranges should be viewed with caution because of the low number of fish marked and recaptured. Based on these estimates there are 2.1 adult Pike and 0.3 adult Walleye per surface acre of Long Lake.

Centrarchid Electrofishing

During the night of May 22, 2017, the entire 2.18 mile shoreline was electroshocked to assess the Centrarchid populations of the lake. During the 1.7 hours of shocking, 469 fish representing ten species were captured (Table 11). Total CPE was 215.1 per mile shocked or 265.0 fish per hour shocked. Bluegill and Largemouth Bass dominated our catch with other species captured in lower abundances.

Table 11. The number of each species that were captured by electrofishing during the night of May 22, 2017 in Long Lake. Lengths are reported in mm and in inches (") for each species.

Species	Number	CPE (fish/mile)	CPE (fish/hour)	Size Range	Average Length	Peterson P.E.	P.E. Range
Largemouth Bass	99	45.4	55.9	136 mm-505 mm (5.4"-19.9")	365 mm (14.4")	1386	655-3199
Northern Pike	5	2.3	2.8	527 mm-817 mm (20.7"-32.2")	643 mm (25.3")	297	133-743
Walleye	3	1.4	1.7	350 mm-574 mm (13.8"- 22.6")	468 mm (18.4")	92	28-166
Bluegill	275	126.1	155.4	54 mm-190 mm (2.1"- 7.5")	150 mm (5.9")		
Black Crappie	18	9.2	11.3	110 mm-225 mm (4.3"-8.9")	186 mm (7.3")		
Pumpkinseed Sunfish	6	2.8	3.4	105 mm-174 mm (4.1"-6.9")	141 mm (5.6")		
Yellow Perch	5	2.3	2.8	112 mm-174 mm (4.4"-6.9")	142 mm (5.6")		
Yellow Bullhead	1	0.5	0.6				
Carp	46	21.1	26.0				
Golden Shiner	9	4.1	5.1				
Total	469	215.1	265.0				

Gamefish

Largemouth Bass

Largemouth Bass were the most common gamefish captured during this electroshocking survey (Table 11). The 99 Bass ranged in length from 136 mm to 505 mm (5.4" to 19.9") and had an average length of 365 mm (14.4") (Table 12). Slightly more than half of the captured Bass (51.5%) were greater in length than the 14 " (356 mm) minimum harvest length but only 2.0% were greater than 457 mm (18") in length (Figure 9). Most of the captured Bass were greater than 300 mm (12") in length, with few Bass less than this size captured.

Two of the Bass were recaptures that were marked during previous surveys allowing a PE to be made. The Peterson Estimate for Bass was 1,386 with a range of 655 to 3,199 (Table 11). The PE estimate and range should be viewed with caution because of the low number of fish marked and recaptured.

A dorsal spine was collected from all Bass captured during the two spring electroshocking events for aging. Age 5 and age 6 Bass were the most common followed by age 7 (Table 13). When ages from spring electroshocking are compared to ages from the 2017 fyke survey found in Table 5, both provide similar results with Bass growing at or near State averages at each age.

Table 12. The length distribution of gamefish caught during the May 2017 electroshocking on Long Lake.

Length (in) mm	Largemouth Bass	Northern Pike	Walleye
130	1		
140			
(6") 150			
160	2		
170	4		
180			
190			
(8") 200			
210			
220	1		
230			
240			
(10") 250	4		
260			
270	1		
280	4		
290	1		
(12") 300			
310	3		
320	3		
330	9		
340	8		
(14") 350	7		1
360	6		
370	6		
380	3		
390	1		
(16") 400	2		
410	3		
420	6		
430	2		
440	6		
(18") 450	2		
460	5		
470	1		
480	1		1
490	1		
(20") 500	3		
510			
520	3	1	
530			
540			
(22") 550			
560			
570			1
580		1	
590			
(24") 600		1	

**Table 12
(Cont.)**

Length (in) mm	Largemouth Bass	Northern Pike	Walleye
610			
620			
630			
640			
(26") 650			
660			
670			
680		1	
690			
(28") 700			
710			
720			
730			
740			
(30") 750			
760			
770			
780			
790			
(32") 800			
810		1	
Total	99	5	3
Ave. Length	365 mm (14.4")	643 mm (25.3")	468 mm (18.4")
S.D.	86.7 mm (3.4")	113.2 mm (4.5")	112.5 mm (4.4")

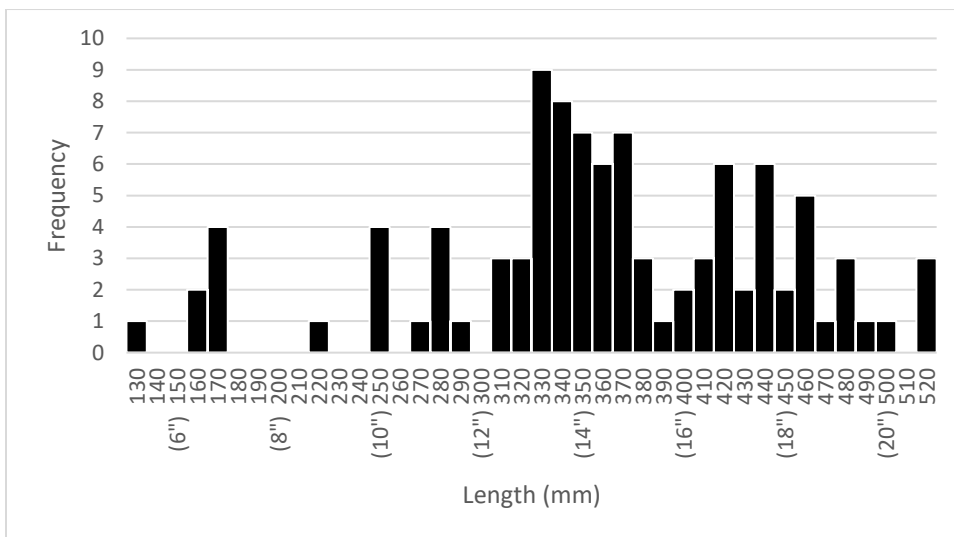


Figure 9. The length frequency distribution of Largemouth Bass captured during the May, 2017 recapture electroshocking on Long Lake.

Table 13. The age distribution of Largemouth Bass captured during electroshocking on Long Lake during the spring of 2017. Lengths are in mm and inches (in).

Length (in) mm	Age											
	2	3	4	5	6	7	8	9	10	11	12	
160	2											
170	4											
180												
190												
(8") 200												
210												
220		2										
230												
240												
(10") 250			5									
260												
270			3									
280			1	3								
290				1								
(12") 300												
310			1	2	1							
320				2	5	1						
330			1	2	2	1						
340				9	9	3						
(14") 350				9	6	2						
360				6	6	1						
370				7	6							
380				1		1						
390						1						
(16") 400					2	1						
410					2	2	1					
420					1	4	3					
430					1	2	1					
440					1	8	4		1			
(18") 450									2			
460						1	2	4	1	1		
470								2				
480								1	1			
490							1		1			
(20") 500									1			
510												
520									1	1	2	
Total	6	2	11	42	42	28	12	7	8	2	2	
Ave. Length	168 (6.6")	225 (8.8")	274 (10.8")	346 (11.6")	361 (14.3")	406 (16.0")	444 (17.5")	461 (18.1")	478 (18.8")	494 (19.4")	523 (20.6")	
S.D.	6.9 (0.3")	2.1 (0.1")	27.2 (0.1")	26.1 (1.0")	30.3 (1.2")	37.3 (1.5")	21.5 (0.8")	16.4 (0.6")	25.6 (1.0")	41.7 (1.6")	2.8 (0.1")	

Northern Pike

Five Northern Pike were captured during May shocking (Table 11). The Pike ranged in length from 527 mm to 817 mm (20.7" to 32.2") and had an average length of 643 mm (25.3") (Table 12). A Peterson PE indicated that 297 (range 133 to 742) adult Pike were in the Lake. This estimate and range should be viewed with caution because of the low number of fish marked and recaptured.

Walleye

Three Walleye were also captured during the shocking run (Table 11). The Walleye ranged in length from 350 mm to 574 mm (13.8 to 22.6") and had an average length of 468 mm (18.4") (Table 12). A Peterson PE estimated that there were 92 Walleye (range 28 to 166) in the lake (Table 11). This estimate and range should be viewed with caution because of the low number of fish marked and recaptured.

Panfish

Bluegill

Bluegill dominated the panfish catch during electroshocking (Table 11). The 255 measured Bluegill ranged in length from 54 mm to 194 mm (2.1" to 7.5") and had an average length of 150 mm (5.9") (Table 14). Although most Bluegill (56.4%) were greater than 150 mm (5.9") in length, none were greater than 200 mm (8") in length.

Table 14. The length distribution of measured panfish caught during the May 2017 electroshocking on Long Lake.

Length (in) mm	Bluegill	Black Crappie	Pumpkinseed Sunfish	Yellow Perch
(2") 50	2			
60				
70				
80	3			
90	3			
(4") 100	3			
110	10	2	1	1
120	19			1
130	40		2	
140	31		1	1
(6") 150	37	1	1	1
160	52			
170	47	1	1	1
180	7	2		
190	1	5		
(8") 200		4		
210		2		
220		1		
Total	255	18	6	5
Ave. Length	150 mm (5.9")	186 mm (7.3")	141 mm (5.6")	142 mm (5.6")
S.D.	22.6 mm (0.9")	30.4 mm (1.2")	23.1 mm (0.9")	25.0 mm (1.0")

Other Panfish

Other panfish, including Pumpkinseed Sunfish, Black Crappie and Yellow Perch were captured during shocking but in low abundance (Table 11). Average lengths were 186 mm (7.3"), 141 mm (5.6") and 142 (5.6") for Black Crappie, Pumpkinseed Sunfish and Yellow Perch respectively (Table 12).

Other Species

Three other species were captured during electroshocking. These species were in decreasing abundance, Common Carp, Golden Shiner and Yellow Bullhead (Table 11).

DISCUSSION

A comprehensive fisheries survey was conducted on Long Lake in April and May, 2017 to assess the fish populations of the lake. Two survey gears, fyke nets and a boomshocker were used to collect fish across the spring spawning seasons. In total, 6,936 fish representing thirteen species were captured. Overall, Black Crappie and Bluegill dominated our catch chiefly because the large number of Crappie and Bluegill captured by fyke nets. Northern Pike, Largemouth Bass and Brown Bullhead were the next most abundant species with other species caught in lower number. In electroshocking surveys, Largemouth Bass and Bluegill dominated our catch.

Gamefish

Northern Pike were the most common gamefish captured during this survey. Captured Pike ranged from 335 mm to 946 mm (13.2" to 37.2") with nearly 50% of the captured Pike greater than the minimum harvest size of 660 mm (26") (Tables 2 and 3). Growth, was average to slightly above average for most Pike (Table 5). Likely abundant panfish contribute to the size of the Pike in Long Lake. Despite low Peterson population estimates, if a multiple census Schnabel estimate is used, it indicates a population nearly ten times higher. The Peterson estimate was based on a small sample size during the recapture event ($N = 5$); therefore, the number may indeed be higher than estimated with the Peterson method. Results from the 2017 survey continued the trend of improving Pike numbers noted in the 2007 survey (Hogler and Surendonk 2008). Likely the improvement in number is due to stocking of large fingerling by the Lake Association which correspond to several strong year classes noted by age analysis (Tables 1 and 5). Small fingerling stocking likely contributed to the fishery although the results are not as clear. Since Pike year classes were noted for some non-stocked years, it is likely some level of natural reproduction is occurring in the Lake that was not noted in the previous three surveys.

The number of Largemouth Bass captured during fyke netting and electrofishing in 2017 increased from what was captured during the 2007 survey (Hogler and Surendonk 2008). Length frequencies for each gear type indicate a good number of older, larger fish in the population, but few fish less than 300 mm (12") in length (Tables 3, 10 and 12). Growth rates were near state averages at all ages for Bass in 2017 (Table 5). More conservative size and bag limits may be needed to increase production of young fish although of habitat loss and continued poor water quality will continue to cause poor recruitment in some years. Protection of spawning areas is also critical for a healthy population of bass.

Walleye were captured in low number during surveys. Stocked fish appear to be growing well, although survival appears low. Reproduction, if present, is extremely limited and maintenance stocking will be required if walleye are to continue as part of the fishery of the lake.

Panfish

Black Crappie and Bluegill dominated the panfish community of Long Lake, although Yellow Perch, Yellow Bass and Pumpkinseed were also captured. The number of captured Black Crappie in 2017 was unexpected since past surveys found only modest numbers of Crappie during each survey (Hogler and Surendonk 2008). Strong Black Crappie year classes from 2010 through 2013 (Table 8) appear to responsible for the increase in number. Although growth is less than average (Table 5), it is likely that these year classes may contribute to good growth rates observed in gamefish populations. Over the next several years, anglers should see larger Black Crappie as these fish age and grow beyond predation size of most gamefish in the lake.

As was the case in past surveys, Bluegill were abundant but small in size with few Bluegill greater than 200 mm (8") in length despite near average growth rates (Table 4). However, despite the lack of large Bluegill in the catch, the average size of a Bluegill captured in fyke nets improved from 112 mm (4.4") in 2007 to 158 mm (6.2") in 2017. Average size also improved for Bluegill captured by electroshocking. The improvement in size observed in 2017 compared to earlier surveys is likely due to reduced competition for food because of reduced Bluegill numbers caused by several fish kills since 2007 survey or from increased predation by predators that have increased in abundance since 2007. Most Bluegill were less than age 6 based on aging (Table 9). Fish may be young (small) because anglers are removing older, larger individuals and leaving younger, small fish in the lake as was observed in the creel survey associated with the 1999 survey (Hogler 2001) or because larger fish were selectively killed by disease during recent fish kills.

Historically, Yellow Bass were a major component of the Long Lake panfish community. Past surveys in 2007 and 2011 found few Yellow Bass since a large fish in 2007 (Hogler 2004). Results from 2017 indicate that Yellow Bass are low in abundance. Time will tell if the yellow bass population will recover following their

latest decline.

Other Fish

Carp and Bullhead are present in Long Lake although the numbers caught in 2017 were substantially less than those captured in 1999 (Hogler 2001). Earlier surveys indicated that their high abundance could negatively impact water quality and ultimately the fish community of the lake. In 2013, the Long Lake Association contracted with a Minnesota commercial fisherman to seine Carp out of the lake. Despite the limited number of Carp that were removed, it is likely that Carp remain abundant in the lake. It is unclear what the impact of the current population of Carp is on Long Lake water quality.

Our surveys revealed that forage species are lacking in this lake. Golden Shiners were the only minnow species collected during surveys. The lack of forage may be the cause for slow growth in some of the fish species.

RECOMMENDATIONS

- Conduct a full comprehensive fish survey every five years to monitor the fish populations of the lake. Each survey should focus on:
 - The abundance and growth rates of Largemouth Bass, Northern Pike and Bluegill.
 - The contribution of stocked Walleye to the fishery.
 - The reproductive status of Northern Pike to determine if continued alternate year stocking is needed.
 - The abundance of forage fish.
- Evaluate the results from the Panfish Study and make appropriate recommendations based on the findings of the study.
- Work with other DNR staff, the Manitowoc County Soil and Water Department, the Manitowoc Lakes Association, the Long Lake Association and local residents to monitor water quality in the lake and to make changes in the watershed designed to improve water quality.
- Encourage the Long Lake Association and shoreline owners to improve nearshore fish habitat by incorporating woody debris in their landscape.

REFERENCES

- Belonger, B. 1973. Survey of Long Lake, Manitowoc County. Unpublished. Wisconsin Department of Natural Resources. 3 pages.
- Hacker, V. 1958. Trap Netting of Long Lake, Manitowoc County. Unpublished. Wisconsin Conservation Department. 3 pages.
- Hogler, S. 1999. 1983 Comprehensive Survey of Long Lake, Manitowoc County. Unpublished. Wisconsin Department of Natural 22 pages.
- Hogler, S. 2001. 1999 Comprehensive Survey of Long Lake, Manitowoc County. Unpublished. Wisconsin Department of Natural 28 pages.
- Hogler, S. 2004. Long Lake Fish Kill Memo. Unpublished. Wisconsin Department of Natural 1 page.
- Hogler, S. 2007. Long Lake May 2007 Fish Kill Memo. Unpublished. Wisconsin Department of Natural 2 pages.
- Hogler, S. 2008. Long Lake Fish Kill Investigation Memo. Unpublished. Wisconsin Department of Natural 1 pages.
- Hogler, S. 2017. Long Lake May 2017 Fish Kill Memo. Unpublished. Wisconsin Department of Natural 1 page.
- Hogler, S and S. Surendonk. 2008. 2007 Long Lake Report. Unpublished. Wisconsin Department of Natural Resources. 8 pages.
- Hogler, S and S. Surendonk. 2011. 2011 Long Lake Fish Kill Investigation Memo. Unpublished. Wisconsin Department of Natural Resources. 1 page.
- Hogler, S and S. Surendonk. 2012. 2011 Long Lake Fish Survey Report. Unpublished. Wisconsin Department of Natural Resources. 22 pages.
- Mackenthun, K. 1947. A Biology Survey of Long Lake, Manitowoc County. Unpublished. Wisconsin Conservation Department. 13 pages.
- Peeters, P. 1981. Long Lake Shocker Survey-Fall 1980. Unpublished. Wisconsin Department of Natural Resources. 5 pages.
- Peeters, P. 1984. Fish Kill on Long Lake Report. Unpublished. Wisconsin Department of Natural Resources. 4 pages.

- Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada. Bulletin 191. Ottawa, Ontario, Canada.
- Schultz, P. 1963. Long Lake, Manitowoc County 1963 survey. Unpublished. Wisconsin Conservation Department. 4 pages.
- Welch, D. 1983. Fishery status of Long Lake, Manitowoc County. Unpublished. Wisconsin Department of Natural Resources. 7 pages.